

# Livestock Policy Analysis Brief No. 17

## A strategy for technology development for semi-arid sub-Saharan Africa

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Pessimistic views are often advanced about the future of agricultural development in sub-Saharan Africa, where rapid population and declining food production growth trends have been observed. This has especially been the case with regard to semi-arid Africa where rainfall is low and irregular, and soils fragile and with low fertility. Such views ignore the fact that there have been successful technological breakthroughs in the semi-arid region which have resulted in substantial agricultural productivity gains. Successful technology introductions have addressed principal constraints of water availability and soil fertility in the semi-arid region. A strategy for the rapid introduction of inorganic fertilisers, combined with techniques that increase water availability and increased organic fertiliser use, is proposed here for semi-arid Africa.

### Constraints to yield increases in semi-arid sub-Saharan Africa

Two principal constraints to increased crop yields in semi-arid sub-Saharan Africa can be hypothesised to be low levels of soil nutrients and lack of enough water at critical stages in the crop production cycle. Because of low and irregular rainfall, semi-arid regions usually lack sufficient water for sustained crop production increases. This is aggravated by soil crusting which leads to reduced water infiltration.

Under such circumstances, making water available when soil nutrients are very low will result in low crop yield. Similarly, applying fertilisers when water is inadequate will lead to low yield and also prove economically risky. Combined technologies to increase soil water availability and crop nutrient levels through, for example, water retention devices, have been shown to increase crop yields substantially and to be highly profitable. Under conditions of soil degradation and falling marginal productivity of farm labour, these technologies are land substituting and increase labour use.

### Some success stories

An important question in terms of technology development is whether newly introduced agricultural technologies in semi-arid West Africa have been consistent with identified constraints of water availability and soil nutrient levels.

In the Sudano-Guinean zone, which has sufficient rainfall in most years, the introduction of new cotton and maize cultivars, combined with increased organic fertiliser use and improved agronomic practices, appears to have resulted in substantial yield increases.

In the Sudanian and Sahelo-Sudanian zones, where rainfall is much lower, contour dikes have been

introduced to slow soil erosion and water runoff. Combined with organic fertiliser application and improved early varieties of cereals and cowpeas, these dikes have increased yields under adverse rainfall conditions. Dikes have been especially popular in severely degraded regions where they have been constructed during the slack season when opportunity costs of family labour are generally low.

Given that water retention devices tend to be extremely labour intensive, they have first been adopted in those regions with severe soil nutrient depletion and high population pressure. In regions with lower population pressure and sufficient resources, other technologies to increase water retention can be expected to be adopted as the available crop area for expansion decreases and the value of agricultural products increases.

## **Potential technologies for the Sudanian region**

Apart from the dikes/organic fertiliser combination, there are many other high-yielding water retention/soil fertility techniques. These include the combination of tied ridges and inorganic fertiliser, and the digging of small holes (*zia*) around which to plant, introduced in the degraded Sudanian region of Burkina Faso.

According to model predictions from this study, higher population pressures leading to decreasing land availability will induce more rapid shifts to combined technologies in the semi-arid region. Another critical factor affecting technology introduction in this region is the profitability of agriculture. As the profitability of agriculture increases with changes in output and input prices, model results indicate that farmers shift to more intensive production practices, extending the area in tied ridges and increasing the use of fertilisers.

These model results are confirmed by numerous field observations which show that adoption of dirt-and-stone dikes, organic and inorganic fertilisers, supplementary irrigation for out-of-season vegetable and fruit production, ridging on animal traction farms, improved crop varieties etc has rapidly increased in the Sudanian and Sahelo-Sudanian regions.

Overall, the model results for potential technology introduction in the semi-arid zone are consistent with the proposed strategy of technology development. The difficulty of simultaneously introducing a water-retention technique, fertilisers and new animal-traction implements may explain previous failures in technology introduction. But with reduced land availability, increasing population densities and donor pressure, African governments have been encouraged to pursue policies promoting the adoption of yield increasing technologies.

## **The road ahead**

The proposed strategy challenges the conventional view that semi-arid sub-Saharan Africa is a land surplus region with seasonal labour availability being most limiting for increased output. It argues that the principal constraints to higher yields in semi-arid sub-Saharan Africa are low soil fertility and lack of water at critical stages in the crop production cycle.

Failure to identify the above constraints has had important implications for both agricultural research and policy in sub-Saharan Africa. Indeed, many argue that increased organic fertiliser use would enable African governments and farmers to save foreign exchange and costly input purchases. Notwithstanding the numerous alternatives identified through research, however, inorganic fertiliser remains the most viable technology component for increasing yields in semi-arid regions.

This is despite the fact that the removal of fertiliser subsidies and currency devaluation which occurred in many African countries in the late 1980s as part of structural reform programmes, have significantly reduced the relative prices of organic to inorganic fertilisers. While this has led to some increase in manure production technology, supply of organic fertilizers is generally limited by the size of animal herds and the transformation technologies available in most African production systems.

Given such limits to substitution potential, organic and inorganic fertilisers need to be considered as complements in semi-arid regions. Further research to find low-cost complementary practices to inorganic fertiliser should not preclude more rapid adoption of inorganic fertilisers. Inorganic fertilisers need to be combined with increased water retention techniques and improved cereal cultivars to lead to higher returns and yields in the semi-arid region. African farmers need to take advantage of the yield increases possible with inorganic, and to some extent organic, fertilisers. For this to occur substantially more public and private investments supporting the fertiliser and seed industries, and research on organic fertilisers are required.

For further information on this issue see: Sanders J.H., Shapiro B.I. and Ramaswamy S. 1998. A strategy for technology development for semi-arid sub-Saharan Africa. *Outlook on Agriculture* 27(3):157–161.